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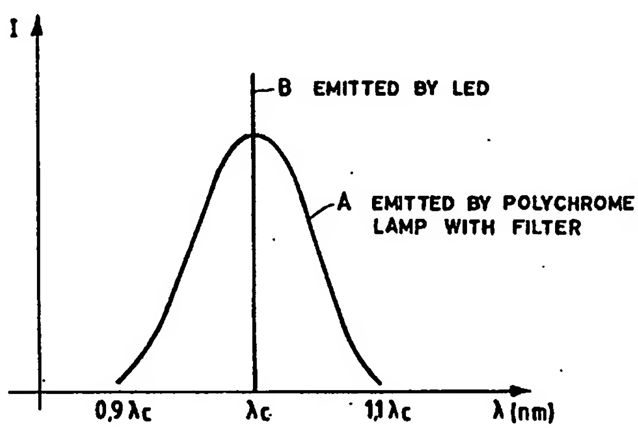


(57) Abstract

An apparatus for colour therapy comprises a diffuser (10, 15) of coloured light, comprising a plurality of monochromatic emission LED diodes (12) having at least two sections corresponding to two colours with frequencies defining a range included within the field of visible light. The diffuser is coupled to a feed and control unit (13) through which the frequency of a radiation of monochromatic light can be selected within said range of frequencies. The feed and control unit provides coloured light intensity regulation and constant variation and allows to select or pulse the intensity of the radiation of monochromatic light.

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# A LED diode apparatus for colour therapy.

## DESCRIPTION

### Field of the invention

The present invention pertains to the field of colour therapy or biostimulation of epidermal tissue by applying coloured light. More particularly, the invention relates to a colour therapy apparatus making use of LED diodes as monochromatic coloured visible light sources.

### Background of the invention

At present, apparatuses of known kind which are designed for carrying out colour therapy are characterized by being able to carry out treatments by using static monochromatic light or polychrome light, the colour of which may be selected from a number of available colours by laying a selective chromatic filter over a source of light (a lamp emitting white polychrome light).

Said filter is known to be made of gelatine or a prism capable of selecting the desired colour of light by refraction.

The chromatic filter allows to isolate a light composed of electromagnetic waves having wavelength comprised within a certain interval, depending on the filter's selectivity. The width of the interval is $\lambda c \pm 10\%$ ($\lambda c$ being the characteristic wavelength of the filter). It is known that each electromagnetic wave that is emitted is associated with a certain amount of luminous energy, which is maximum for the characteristic frequency of the filter and decreases according to a Gaussian curve, as shown in the graph of FIG. 1. Accordingly, for each single harmonic of the aforesaid electromagnetic waves, the associated

energy is only a small portion of the total energy of the light passing through the filter.

EP-B-0320080 discloses a system for biostimulation of tissue making use of a plurality of monochromatic radiation sources of a plurality of wavelengths, preferably of at least three different wavelengths. The radiation sources are laser diodes or superluminous diodes controlled by a device for varying radiation frequency and other parameters. The disclosed device is adapted for generating radiation ranging within 650 nm and 1500 nm, i.e. in the infrared field. Therefore, the devise is not capable of providing a visible light changing colour as required for colour therapeutic use.

For therapeutic applications, it is essential that the laser or superluminous diodes of EP-B-0320080 are pulse activated, as the intensity of the radiation emitted by these sources is high and cannot be tolerated by human skin unless applied intermittently. The pulse frequency of the radiation sources determines the power radiated to the patient.

WO-A-92/18200 there is disclose a cutaneous stimulation system exploiting the transmission of coloured light through fibre-optic cable. There are provided at least two sources of light of different colours. The lights are mixed in a mixer upstream of the fibre-optic cable to obtain the desired frequency. The frequency and intensity of the light emitted by each of the sources are adjustable by a control device.

Summary of the invention

It is an object of the present invention to provide and make use of an apparatus capable of obviating the above prior art drawbacks and being adapted for several therapeutic uses.

In accordance with one aspect of the invention as claimed, this object is accomplished by the provision of an apparatus for colour therapy, comprising:

at least one diffuser of coloured light, comprising a plurality of monochromatic emission LED diodes having at least two sections corresponding to respective first and second colours with frequencies included within the field of visible light, thereby defining a range of intermediate colours or frequencies between said first and second colours;

a feed and control unit operatively coupled to said diffuser, comprising:

frequency regulation means for selecting the frequency of a radiation of monochromatic light within said range of frequencies; and

intensity regulation means for selecting the intensity of said radiation of monochromatic light.

<u>Brief description of the drawings</u>

The characteristics of a few preferred but not limiting embodiments of the apparatus according to the invention are described hereinafter with reference to the accompanying drawings, in which:

FIG. 1 is a diagram showing a comparison between a monochromatic light and a polychrome light selected by a filter;

FIGS. 2 and 3 schematically illustrate two forms of coloured light diffusers included in the apparatus of this invention, respectively;

FIG. 4 diagrammatically shows the feeding stage of electronic circuits of a feed and control unit for the diffusers of FIGS. 2 and 3;

FIGS. 5 to 7 show the electronic circuits generating references for controlling the light emitted by the coloured light diffusers; and

FIGS. 8.1, 8.2, 8.3 and 8.4 represent the waveforms of the signals in the points indicated by alphabetic letters in FIGS. 5 to 7.

Detailed description of preferred embodiments

With reference initially to FIG. 2, numeral 10 indicates overall a coloured light diffuser in the form of a flat screen. In use, diffuser 10 is be directed facing the part of the patient's body to be subjected to colour therapy. The surface of diffuser screen 10 is fitted with one or more panels 11 each comprising a plurality of LED diodes. The LED diodes are of the type with at least two sections corresponding to at least two colours included within the range of visible light.

In the embodiment illustrated in FIG. 2, the LEDs are of the red-green bicolour type. As will be more apparent hereafter, the wavelength of the light emitted by the LEDs 12 can be selected or varied continuously within the 530÷660 nm range by means of a feed and control unit 13. The limits of said interval correspond to green and red light, respectively.

The imminent provision of a three-coloured LED, at

present not available in commerce yet, will advantageously allow to widen the above cited range of wavelenghts up to 425÷660 nm.

The flat screen diffuser 10 of FIG. 2 comprises, for example, four panels 11. The LEDs 12 are distributed according to a square pattern with a density of one LED/cm$^2$, with 5 mm diameter LEDs.

Preferably, in order to widen the range of frequencies obtainable by the colour therapy apparatus of the present invention, among the bicolour LEDs 12 there is distributed uniformly a plurality of blue coloured LED diodes 14 having a monochromatic emission of fixed wavelength within the 425÷470 nm range. The fixed colour (blue) LEDs 14 are fed by the feed and control unit independently of the bicoloured LEDs. Besides attaining a blue coloured light when the bicolour LEDs 12 are off, a violet colour can be obtained by activating the blue LEDs 14 and simultaneously the bicolour LEDs 12 selecting the red colour for these.

As will be apparent, the number and size of the panels, the number and arrangement of the light sources are variable depending on the broadness of the area which is to be irradiated and the kind of therapy. Tests have proved that a LED density of one LED/cm$^2$ with a distribution ratio of one blue fixed wavelength LED ($\lambda$ = 425÷470 nm) every four bicolour LEDs ($\lambda$ = 530÷660 nm) is advantageous in many applications.

With reference to FIGS. 4, 5, 6 and 7 taken into consideration with FIGS. 8.1, 8.2, 8.3 and 8.4, the functional principle of the electronic circuits of the device controlling the monochromatic sources of light is

described. Said electronic circuits can be identified in three stages: a feeding stage, a reference and modulation generation stage, and a driver stage (FIG. 4).

The feeding stage provides for generation of feedings for both control and power electronic circuits. The feeding stage is composed of a transformer 1, power supplied by line voltage. Two outputs of transformer 1 feed two single-phase rectifier bridges indicated by numerals 2 and 3. Rectified voltages are levelled by suitable capacitors.

Feed voltage of the power circuits is not regulated, while a voltage regulator is provided for regulating voltage of the control circuits.

The reference and modulation generation stage (FIG. 5) has the function of providing voltage references which are necessary for obtaining the driving required by the sources of light. With the purpose of providing dynamic regulation of the colour and intensity of the light emitted by the sources of light, several regulation potentiometers P1-P6 are provided in the circuits generating the colour and intensity of light references.

Colour reference.

The circuit is composed of a triangular wave generator G.O.T.1 comprising operational devices A1 and A2. Said triangular wave generator provides variable voltage at its output point A (voltage is variable within the $+V_{feed}/-V_{feed}$ range). The waveform (shown in FIG. 8.1) has constant amplitude and frequency which can be adjusted by potentiometer P1 illustrated in FIG. 5. The so obtained signal is transformed into a current signal having the same waveform and variable intensity (through potentiometer P3),

as shown in the graph of FIG. 8.1. Said signal is added to the current signal adjustable by potentiometer P2 through the operational device A3.

At the output (point B), the signal indicated in FIG. 8.2 is obtained. This signal is characterized by a continuous voltage component (bias voltage adjustable through potentiometer P2) to which a triangular tension component is added. This triangular tension component is variable in amplitude (through potentiometer P3) and in frequency (through potentiometer P1).

The voltage level of the colour reference identifies the kind of colour of the emitted light.

Accordingly, the magnitude of the alternating component of the voltage signal added to the continuous component (bias voltage) of said voltage signal identifies the range of the desired colour.

Intensity and amplitude modulation reference.

The circuit is composed of a triangular wave generator G.O.T.2 comprising operational devices A4 and A5. Said triangular wave generator provides variable voltage at its output point C (voltage varies within the $+V_{feed}/-V_{feed}$ range). The waveform (shown in FIG. 6.1) has constant amplitude and frequency which can be adjusted by potentiometer P5 illustrated in FIG. 5. The so obtained signal is transformed into a current signal having the same waveform and variable intensity (through potentiometer P6), as shown by the dashed line in the graph of FIG. 8.1.

Said signal is then added to the current signal adjustable by potentiometer P4 through the operational device A6.

At the output (point D), the signal indicated in FIG. 8.2 is obtained. This signal is characterized by a continuous voltage component (bias voltage adjustable through potentiometer P4) to which a triangular tension component is added. This triangular tension component is variable in amplitude (through potentiometer P6) and in frequency (through potentiometer P5). The signal obtained in point D, representing the reference of the intensity of light emitted by the sources of light is compared to the signal obtained in point E, which is generated by triangular wave generator G.O.T.3, through operational device comparator A9.

Triangular wave generator G.O.T.3 comprises operational devices A7 and A8 as well as a few passive components indicated overall with reference letters R and C.

The unit formed by triangular wave generator G.O.T.3 and operational device comparator A9 constitutes the amplitude modulation circuit.

At point F, said amplitude modulation circuit provides the amplitude modulation signal of the feed current for the sources of light as a function of the intensity reference voltage signal (point D).

The amplitude modulation signal provided at point F at the output of the operational device/comparator A9 is exploited in the driver stage to carry out regulation of the intensity of light emitted by the sources.

The signal obtained in point D identifies the value of the intensity of the emitted light, which can be constant or varying in time. If the signal is constant, a fixed

light will result. Instead, if the value of the signal is variable, the light will pulse.

The driver stage.

This is the stage that allows to drive the sources of light through transistors T1-T2-T3, as shown in FIGS. 6 and 7. Particularly, FIG. 6 represents the driver stage of a monochromatic source of light, while FIG. 7 represents the driver stage of two integrated monochromatic sources of light.

The reference signal of light intensity obtained at point D (FIG. 5) can be provided by the driver stage in both the examples shown in FIG. 6 and FIG. 7 utilising known regulation techniques: analog or P.W.M..

In case an analogical technique of regulation is chosen, the voltage signal of the luminous intensity reference obtained at point D of FIG. 5 is used to regulate the voltage of the power feed of the transistors. On the other hand, in case a P.W.M. technique of regulation is chosen, the amplitude modulation voltage signal obtained at point F of FIG. 5 for driving the transistors.

FIG. 8.3 reports voltage signals obtained at points D, E, of FIG. 5 compared by the operational device/comparator A9.

The amplitude modulation voltage signal obtained at the output of the operational device comparator A9 (point F) cuts off transistors T1-T2-T3 (through diodes D1-D2-D3 indicated in FIGS. 6 and 7) for a period in which said signal is in the low state ($V_{feed}$-).

This allows a variation of the medium value of the current in the sources of light with a consequent variation

of the luminous intensity emitted by the same sources.

FIG. 8.4 shows the waveform of the voltage signal obtained at point F (amplitude modulation) in FIG. 5. The colour reference signal obtained at point B of FIG. 5 is actuated by the driver stage through two separate circuits depending on whether the source of light is a single monochromatic source or it is formed by two integrated monochromatic sources.

FIG. 6 illustrates the driver circuit of a single monochromatic source. This circuit is made up of operational devices A10-A11-A12 which give a voltage signal at point L. Such signal reaches level $V_{feed}+$ when the value of the signal of the colour reference is within the voltage limits set by potentiometers P7 and P8.

Said modulated signal, through diode D1, from the amplitude modulation signal, regulates through transistor T1 the current activating the source of monochromatic light. This source can be a monochromatic LED of blue, red, green, yellow, orange colour, characterized by the fact that the emission of light from two or more LEDs of the same colour takes place on a wavelength λ where the medium value oscillates within ± 2%.

As to non-available colours of the actual variety of LEDs, the driver stage described in FIG. 6 is used to drive two LEDs of appropriate colours in order to obtain the desired colour of light. This light is achieved by mixing the two monochromatic lights attained through a diffuser screen such as a frosted sheet of glass or Plexiglas.

FIG. 7 shows the driver circuit of two integrated monochromatic sources of light.

The circuit is composed of a triangular wave generator G.O.T.4 comprising operational devices A13-A14.

Said triangular wave generator provides variable voltage at its output point G. This voltage varies within the $+V_{feed}$ / $-V_{feed}$ range according to the waveform shown in FIG. 8.3.

Frequency of the triangular wave is about 1 kHz, which is high with respect to the range of frequencies that can be seen by the human eye. The voltage signal obtained in point G is compared to the colour reference voltage signal by operational device A15.

The output voltage signal of operational device A15 at point H is utilised for driving transistor T3. The same voltage signal (point H) is inverted by the operational device A16 (point I) and used for driving transistor T2. By varying the voltage of the reference of colour (point B, FIG. 5), also the percentage of the conduction period of transistors T2-T3 varies. Consequently, the mean values of currents feeding the two integrated chromatic sources of light will vary. Such a source of light can be identified with a multi-colour LED.

At present, two-colour LEDs are available in red-green, yellow-green, green-orange.

As the values of the two voltage signals achieved in points H and I (FIG. 7) are complementary, the intensity of the light emitted by the two sections of the LED will also have a complementary value.

The mixing of the lights emitted by the two sections of the LED generates the complete variety of chromatic lights comprised between the characteristic values of the

two-colour LED being used. Also in this case, diodes D2 and D3 (FIG. 7) provide for adjustment of the intensity of light emitted by the two sections of the LED as a function of the voltage of modulation amplitude signal (point F, FIG. 5).

FIG. 8.3 reports the waveforms of the output signals concerning reference of colour (point B, FIG. 5) and the output signal of the triangular wave generator G.O.T.4 (point G, FIG. 7).

FIG. 8.3 reports the waveforms of the voltage signals attained at points H and I (FIG. 7) which are used for driving transistors T2-T3.

It is understood that control of monochromatic sources can be achieved also through digital techniques, for example by using a microprocessor, without departing from the scope of this invention.

The feed and control electronic unit 13 provides current variation to the radiation sources depending on the selected function and the colour reference (generated by the operational circuits), so as to attain alternatively one of the following four modes of therapeutic light emission:

a) a radiation of substantially monochromatic light having constant intensity, the wavelength being substantially selectable in a continuous mode by a potentiometer within the 425÷660 nm range;

b) a radiation of substantially monochromatic light having a wavelength substantially selectable in a continuous mode by a potentiometer within the 425÷660 nm range, the intensity being variable in time with pulses

having a 0,2÷20 Hz frequency;

c) a radiation of substantially monochromatic light having constant intensity, the wavelength varying continuously and periodically within the 425÷660 nm range, the period of the frequency variation being selectable by a potentiometer within a 0,2÷20 Hz range;

d) a radiation of substantially monochromatic light having wavelength varying continuously and periodically within the 425÷660 nm range, the period of the wavelength variation being selectable within a 0,2÷20 Hz range, the intensity being variable in time with pulses having a 0,2÷20 Hz frequency.

Referring now to FIG. 3, there is shown an alternative embodiment of the apparatus according to the present invention. The diffuser screen 10 has been replaced by a point diffuser in form of a substantially tubular manual device 15 with a conical end portion 16.

As discussed above with reference to the diffuser screen, the point diffuser 15 contains a plurality of LED diodes (not shown) the light of which is guided by the conical point 16 through the end opening 17. The luminous flux coming out of the opening is concentrated with an intensity generally exceeding the one obtainable with a screen, and it is accurately addressed to a specific point of the patient's body.

A tubular diffuser having a diameter of 50 mm may accommodate about twenty LEDs fitted immediately before the conical point 16 and mounted on a flat supporting member (not shown) transverse to the longitudinal axis of the tubular body 15. This embodiment is particularly adapted

for colour puncture applications: the diffuser is to be brought near the area to be treated, and the so called acupuncture energy point are stimulated.

A further embodiment of the invention (non shown in the drawings) is particularly adapted for trichology applications. A number of panels (like the ones shown in FIG. 2) are fitted to a concave surface, so as to cause the luminous radiation to converge on the scalp to be stimulated. More particularly, to reach the best results, the LED diode panels are inserted on the inside surface of a hair dryer helmet.

As will be appreciated, the light sources used with the apparatus of the present invention emit radiations that are not harmful for any part of the human body, particularly the eyes.

The apparatus of the present invention is suitable to carry out the following treatments:

1. diffusion of monochromatic light in colours comprised within the field of the visible (425÷660 nm) on areas of issue of the human body, choosing between fixed colour, pulsed colour and automatic variation of colour selecting the frequency of such variation;

2. diffusion of monochromatic light in colours comprised within the field of the visible (425÷660 nm) on energy point of the human body, choosing between fixed colour, pulsed colour and automatic variation of colour selecting the frequency of such variation.

In both of the above methods, the irradiation generates an energetic field that extends to the whole body, influencing in a determining way the biochemical

processes of the body.

The colour oscillation that is transmitted through the areas or the system of meridians through the energy points, causes the single cells of the body to assume an oscillatory behaviour, thereby re-organising the arrangement of the lipid and protein molecules within the cell membrane. This phenomenon is enhanced upon reaching resonance of colour oscillation with cell oscillation, thereby improving cell operation with consequent production of more strong and healthy cells.

At the same time, the structures of the cells of immunity are re-arranged so that these cells become more efficient in creating a defensive barrier against diffusion of virus and bacteria.

The following examples briefly report the results of several applications carried out with important institutes of physiotherapy and aesthetic medicine.

Example 1

About 50 patients afflicted with phlebitis, of which only 20 were subjected to pharmacological therapy, 20 applications have been carried out with red coloured light for 10 minutes and pulsed red light for 5 minutes in each daily application. The swelling and inflammation decreased, while circulation returned to normal and pain disappeared. The results were accomplished after the first 10 applications and were consolidated with 10 further applications. Patients that were treated also with pharmacological therapy attained results quicker.

Example 2

50-60 year old patients afflicted with chronic rheumatism were treated with fixed red coloured light for 10 minutes and orange pulsed light for 8 minutes stated that after a cycle of 20 daily applications pain relief was considerable (about 60%).

Example 3

Patients afflicted with cystitis, treated with fixed yellow coloured light for 10 minutes and a pulsed "sweep" of colours for 8 minutes declared their problem was over after 4 daily treatments.

Example 4

A 50 year old patient afflicted with persisting hemicrania was treated with green light on energy points and diffusion of green for 10 minutes and yellow for 5 minutes. After 10 applications twice-weekly, the pain was eliminated, while it has already diminished considerably after the second application.

Example 5

Patients having tendency to water retention with formation of oedema, especially on the legs, were treated twice-weekly with diffused violet light for 10 minutes and yellow for 5 minutes. After an average of about 12 application the lymphatic system was re-activated, diuresis was increased, swelling diminished. The patients experienced a sensation of lightness and well-being.

Example 6

Patients afflicted with cellulitis were treated with applications of colour adapted to the morphology, on energy points of various areas of the body and diffusion on zones. Orange light was applied to the energy points of a sanguine patient, with green fixed colour applied to the abdomen and pulsed sweep of colour on the back for 5 minutes. After 12 weekly applications, in combination with conventional anti-cellulitis treatments, reaction time was reduced of about 50% and the zones afflicted with cellulitis showed physiological improvements.

Example 7

Patients afflicted with problems of hair loss, excess of sebum, dandruff, inflammation of the scalp, were treated with success by the apparatus of the invention. The choice of colour and its dynamic features was made with regard to the patient's pathology and morphology.

Nervous subjects exhibiting dry hair, dry dandruff, hair loss due to scarce oxygenation, shrunk cutis, underwent diffused orange coloured light for 8 minutes, sweep of colour for 5 minutes and sweep and pulsing colour for 5 minutes.

All of the patients (about 50) showed the following results after twice-weekly applications:

- hair loss was stopped;
- patients generally experienced a hair growth reprise depending on the age and baldness of the patient, with hair growing thicker;

- elimination of sebum excess and greasiness;
- elimination of dandruff;
- elimination of cutis inflammation and regain of skin elasticity.

CLAIMS

1. An apparatus for colour therapy, comprising:

at least one diffuser (10, 15) of coloured light, comprising a plurality of monochromatic emission LED diodes (12) having at least two sections corresponding to respective first and second colours with frequencies included within the field of visible light, thereby defining a range of intermediate colours or frequencies between said first and second colours;

a feed and control unit (13) operatively coupled to said diffuser (10, 15), comprising:

frequency regulation means for selecting the frequency of a radiation of monochromatic light within said range of frequencies; and

intensity regulation means for selecting the intensity of said radiation of monochromatic light.

2. An apparatus according to claim 1, wherein said frequency regulation means comprise manual regulation means for selecting in a continuous mode a desired frequency within said range of frequencies.

3. An apparatus according to claim 1, wherein said frequency regulation means comprise automatic regulation means for varying continuously the frequency of said monochromatic radiation within said range of frequencies.

4. An apparatus according to claim 3, wherein said automatic regulation means comprise means for selecting an interval comprised within said range of frequencies, so as to vary continuously the frequency of said monochromatic radiation within said interval.

5. An apparatus according to claim 1, wherein said intensity regulation means comprise manual regulation means for selecting in a continuous mode a desired intensity.

6. An apparatus according to claim 1, wherein said intensity regulation means comprise automatic regulation means for varying periodically the intensity of said monochromatic radiation.

7. An apparatus according to claim 1, wherein the diffuser (10) comprises a substantially flat screen.

8. An apparatus according to claim 7, wherein the LEDs (12) are distribute d uniformly on the screen (10) with the density of one LED every 0,6-1 $cm^2$.

9. An apparatus according to claim 1, wherein the diffuser (15) comprises a hollow body containing the LEDs (12) at the inside, said hollow body being provided with a small opening (17) to allow the exit of a concentrated luminous flux.

10. An apparatus according to claim 9, wherein said opening (17) is fitted on a conical end portion of the diffuser (15) so as to concentrate the luminous flux towards said opening.

11. An apparatus according to claim 1, wherein the frequencies of said first and second colours correspond to wavelegnths differing of at least 50 nm.

12. An apparatus according to claim 1, wherein said LEDs (12) are two-coloured, defining a wavelength range of about 530÷660 nm; the diffuser (10, 15) further comprising a plurality of fixed colour monochromatic LED diodes (14) having a frequency external to said frequency range; said fixed colour LEDs (14) being fed and regulated

independently of the bicolour LEDs (12) so as to widen the range of obtainable colours.

13. An apparatus according to claim 12, wherein the wavelength of the fixed colour LEDs (14) is of about 420-430 nm, the range of colours attainable by the two-coloured LEDs (12) being of about 530÷660 nm.

14. An apparatus according to claim 12, wherein the fixed colour LEDs (14)are mixed with the two-coloured LEDs (12).

15. An apparatus according to claim 12, wherein the number of fixed colour LEDs (14) does not exceed about 1/3 of the number of two-coloured LEDs (12).

16. An apparatus according to claim 1, wherein said LED (12) is a three-coloured LED capable of covering a 425÷660 nm wavelength range.

17. An apparatus according to claim 1, wherein said LED diodes (12) are distributed on the concave surface of a hair dryer helmet.

18. Use of an apparatus as claimed in any of the preceding claims for colour therapy applications.

19. Use of an apparatus as claimed in claim 9, for colour puncture applications.

20. Use of an apparatus as claimed in claim 17 for trichology applications.

Fig.1

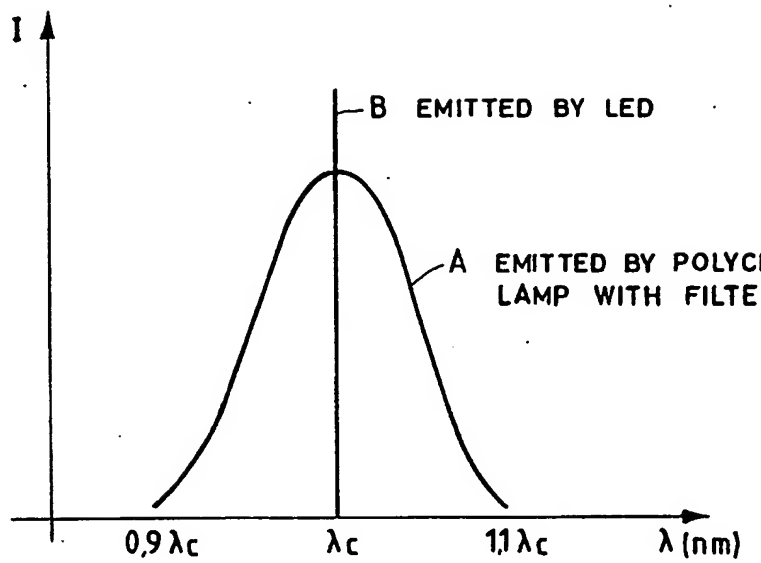

I
B EMITTED BY LED
A EMITTED BY POLYCHROME LAMP WITH FILTER
0,9 λc
λc
1,1 λc
λ (nm)

Fig.4

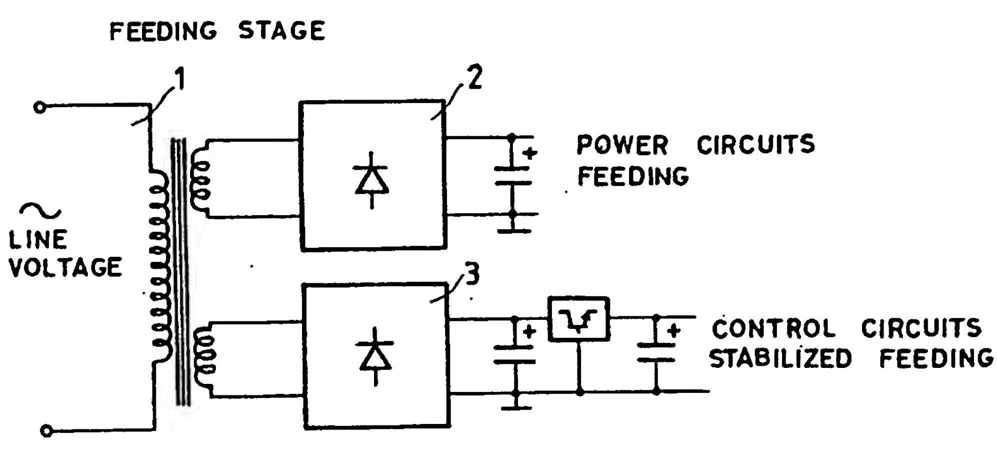

FEEDING STAGE
1
2
3
~ LINE VOLTAGE
+
POWER CIRCUITS FEEDING
CONTROL CIRCUITS STABILIZED FEEDING

Fig.2

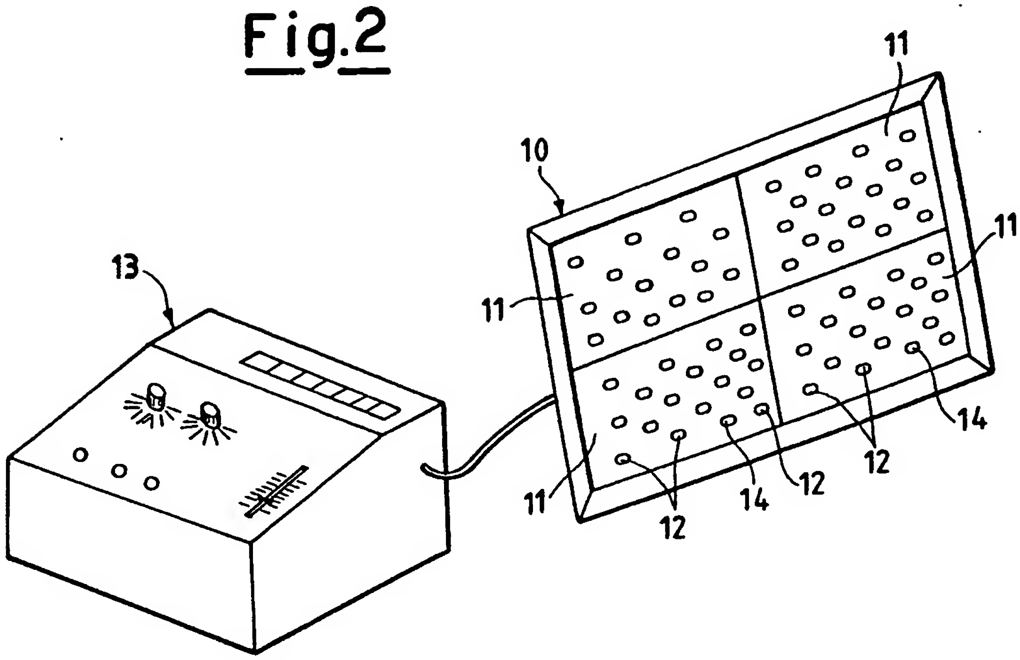



Fig.3

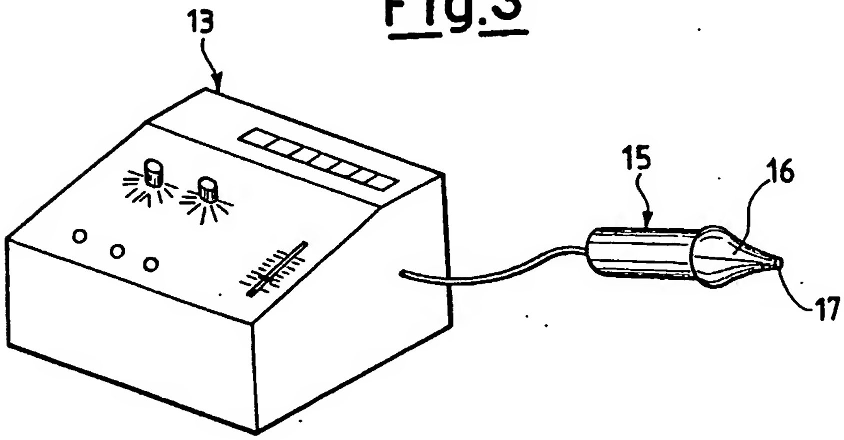


Fig.5

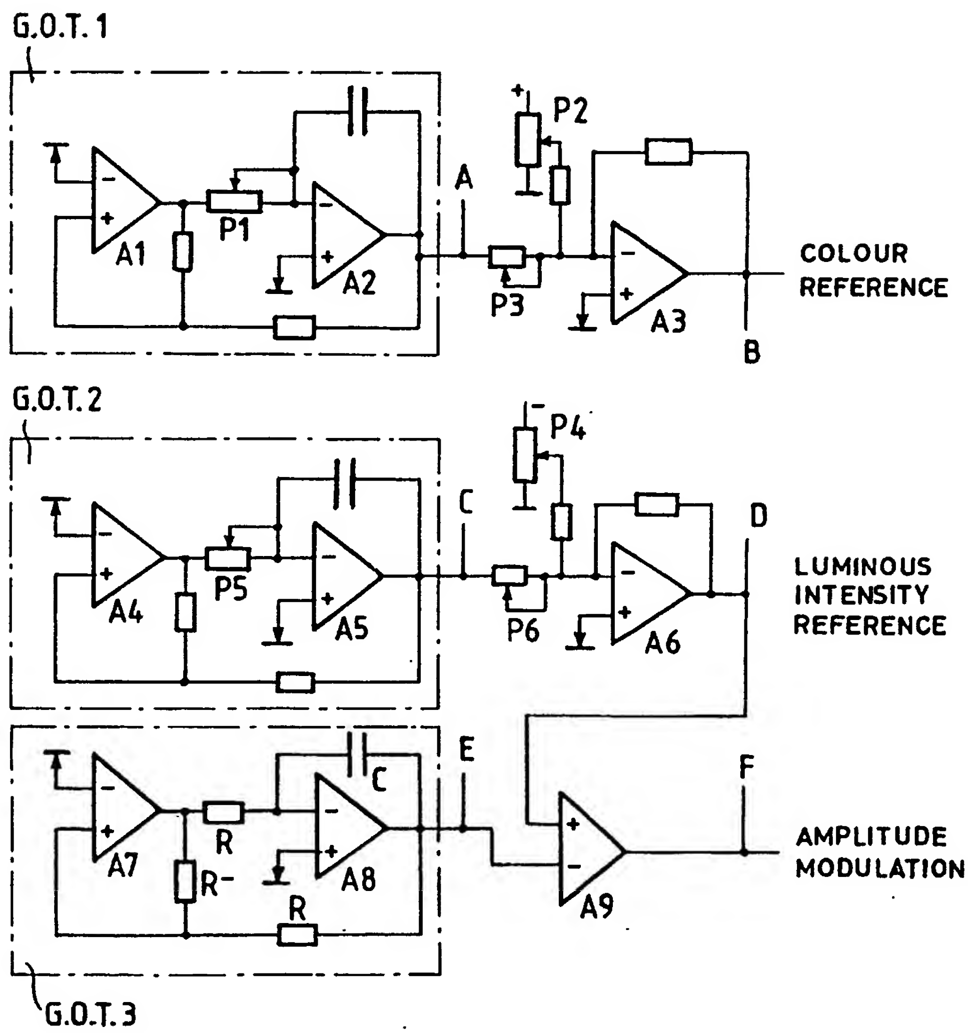

G.O.T. 1
P2
A
P1
A1
A2
P3
A3
COLOUR
REFERENCE
B
G.O.T. 2
P4
C
D
P5
A4
A5
P6
A6
LUMINOUS
INTENSITY
REFERENCE
E
C
F
R
A7
R
A8
R
A9
AMPLITUDE
MODULATION
G.O.T. 3

Fig.6

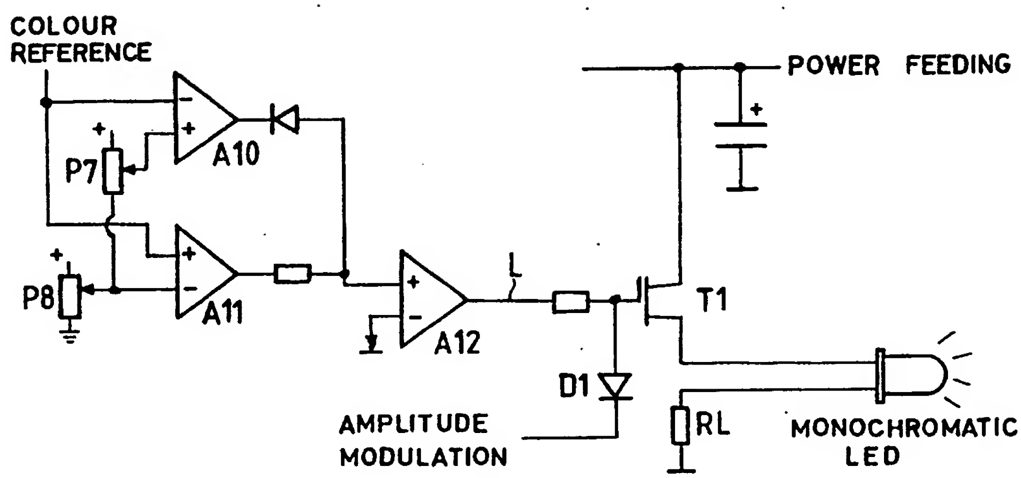
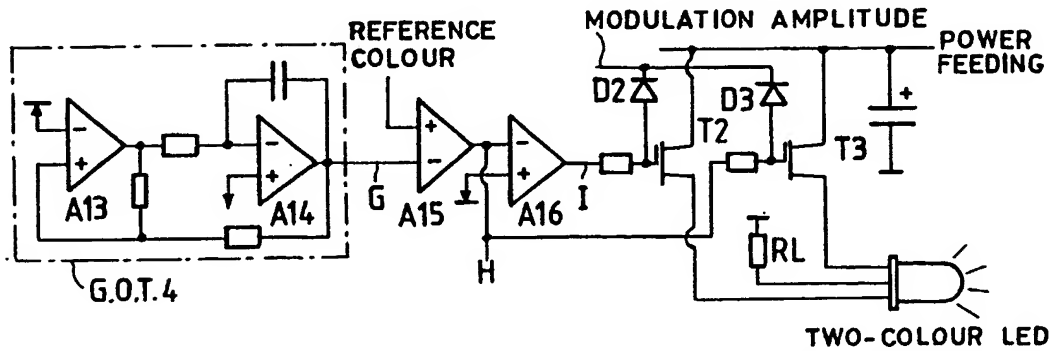

COLOUR
REFERENCE
POWER FEEDING
A10
P7
P8
A11
A12
L
T1
D1
AMPLITUDE
MODULATION
RL
MONOCHROMATIC
LED

Fig.7


REFERENCE
COLOUR
MODULATION AMPLITUDE
POWER
FEEDING
D2
D3
T2
T3
A13
A14
G
A15
A16
I
H
RL
G.O.T.4
TWO-COLOUR LED

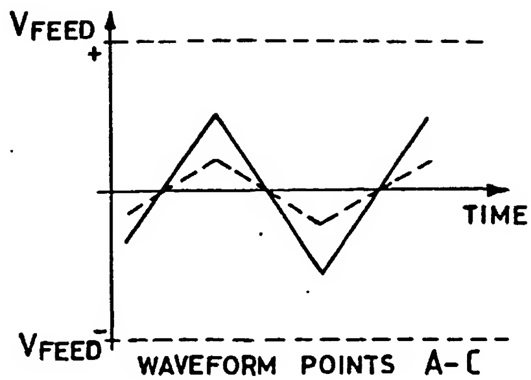



Fig.8.1

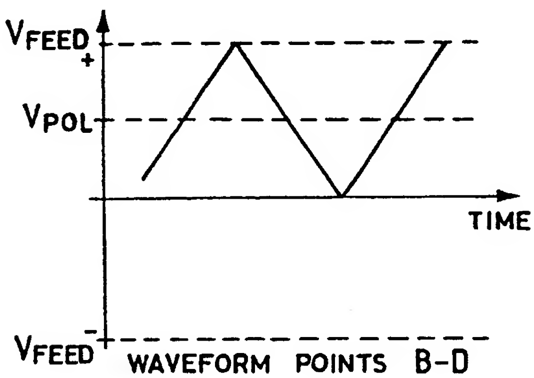



Fig.8.2

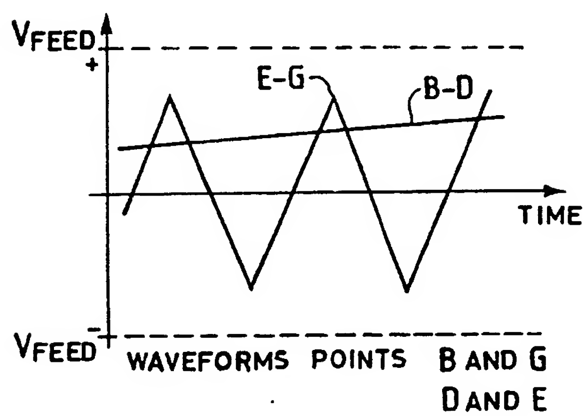



Fig.8.3

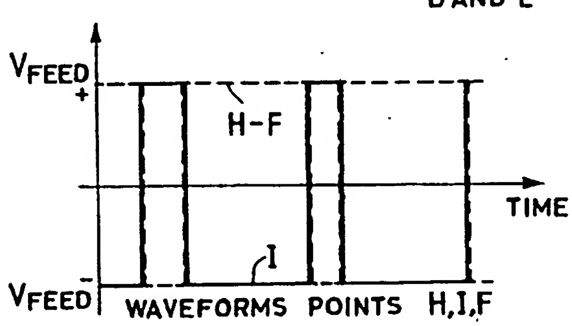



Fig.8.4

# INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 95/01153

**A. CLASSIFICATION OF SUBJECT MATTER**
IPC 6 A61N5/06

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 A61N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category * | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X | WO,A,92 18200 (SCHMID) 29 October 1992<br>see page 4<br>see abstract; claims 1,6<br>--- | 1-3,5 |
| A | EP,A,0 320 080 (DIAMANTAPOULOS) 14 June 1989<br>see abstract<br>see page 3, line 56 - page 4, line 16<br>see page 5, line 42 - line 50<br>see claims 1,7<br>--- | 1-20 |
| A | WO,A,92 06740 (LERNER) 30 April 1992<br>see column 3, line 25 - line 30; claim 1<br>see abstract<br>----- | 1 |

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 7 August 1995 | 31.08.95 |

| Name and mailing address of the ISA | Authorized officer |
|---|---|
| European Patent Office, P.B. 5818 Patentlaan 2<br>NL - 2280 HV Rijswijk<br>Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,<br>Fax: (+31-70) 340-3016 | Taccoen, J-F |



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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/EP 95/01153

| Patent document cited in search report | Publication date | Patent family member(s) | | Publication date |
|---|---|---|---|---|
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| EP-A-0320080 | 14-06-89 | US-A- | 4930504 | 05-06-90 |
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| | | JP-A- | 1136668 | 29-05-89 |
| WO-A-9206740 | 30-04-92 | FR-A- | 2668068 | 24-04-92 |